BOGUSLAVSKIY, Leontiy Davidovich; SHAL'NOV, A.P., kand.tekhn.nauk, nauchnyy red.; ~~VLADIMIROVICH, A.G., red.;~~ TOKER, A.M., tekhn.red.

[Reference book for young sanitary technicians] Spravochnik molodogo santekhnika. Moskva, Vses.uchebno-pedagog.izd-vo Proftekhizdat, 1960. 324 p. (MIRA 13:9)
(Plumbing)

SH'L'NOV, A. P.

Shal'nov, A. P. "Investigation of methods of laying underground gas lines under urban conditions." Executive Committee, Moscow City Soviet of Workers' Deputies. Moscow Inst of Minicipal Construction Engineers of the Moscow City Executive Committee. Moscow. 1956. (Dissertation for the Degree of Candidate in Technical Science)

So: Knizhnaya letopis', No. 27, 1956. Moscow. Pages 94-109; 111.

SHAL'NOV, A.P.

95-11-10/14

AUTHOR: Shal'nov, A. P., Candidate of Technical Sciences ~~(Moscow)~~

TITLE: For Wider Application of Aerial Gas Pipelines (Shire primenyat' vozdushnyye perekhody gazoprovodov)

PERIODICAL: Stroitel'stvo Predpriyatiy Neftyanoy Promyshlennosti, 1957, Vol. -, Nr 11, pp. 23-25 (USSR)

ABSTRACT: The construction of gas pipelines in towns still presents many difficulties and does not meet the demands made by industrialized building.
Pipelines passing through cities are constructed mainly according to three different systems: a) the pipelines lead along already existing bridges, b) special bridges are constructed for this purpose, and c), and this is frequently the case, by means of sluice pipes, which are being widely used and are characterized by a serious disadvantage: they are absolutely out of reach for the butt-joints of the gas pipeline during balancing.
At present the latest method of loying gas pipelines on the ground is that by means of special connecting sockets. These sockets are fitted with rubber seals and are mounted at the butt joints of the pipeline sections where they have the function of a compensator when the pipeline is extended while the ground is being lowered - Gas pipeline girder systems are most useful for

Card 1/3

95-11-1o/14

For Wider Application of Aerial Gas Pipelines

the bridging of gorges, smaller rivers (up to a width of 15 m) and boggy ground.
These "estacade" consist of a girder with several supports which rests upon the piles by means of a lightly constructed through-going frame (fig. 1). The pipe itself acts as the carrying- or supporting agent, and additional supporting constructions are therefore superfluous. The distance between the supports depende upon the diameter of the gas pipeline and the amount of stress it is subjected to . The usual distance is 8 - 1o m. The total length of a pipeline supporting system can vary between 2o-3o and 13o - 15o m.
Arch bridges consist of two or three arches of pipes which are parallel to one another and cover the entire width of a river, canal, or railroad track (fig. 2). The arches are connected by means of light crossties. A suspended ladder made of steel rods and angle irons leads along the lower part of the arches, which gives free access to the butt-joints and makes it possible to carry out the necessary repair work on the insolating system.
Statical calculations show that, in view of the tensions in the metal which are caused by permanent and temporary stress, the width of span of arch bridges can be considerably increased.

Card 2/3

95-11-10/14

For Wider Application of Aerial Gas Pipelines

These bridges are very easily balanced, and their value is lower by about 2/3 than that of sluice pipes. Arch bridges may be used not only forthe transportation of gas but also for mineral oil, water, and hot water pipelines. There are 5 figures and 1 Slavic reference.

AVAILABLE: Library of Congress

Card 3/3

LYAMIN, A.A., inzh.; ZAKHARENKO, S.Ye., inzh.; SHAL'NOV, A.P., kand. tekhn.nauk; YUSHKIN, A.R., inzh.; FILIMONOV, V.A., inzh. OSTAL'TSEV, P.P.

The technical and economic expediency of the simultaneous installation of underground equipment by engineering teams. Gor.khoz.Mosk. 31 no.11:30-35 N '57. (MIRA 10:12)

1.Mosenergoproyekt (for Lyamin). 2.Mosteploset'stroy (for Zakharchenko). 3.Mospodzemproyekt (for Shal'nov, Yushkin, Filimonov, Ostal'tsev)

(Municipal engineering)

SHAL'NOV, A.P., kand.tekhn.nauk; KISELEV, M.F., inzh.

Trenchless laying of reinforced concrete pipes by the forcing-in method. Stroi.truboprov. 3 no.11:21-23 N '58. (MIRA 11:12)

(Pipelines) (Earthwork)

SHAL'NOV, A.P., kand.tekhn.nauk; KOBISHCHANOV, V.N., inzh., red.

[Combined laying of pipes; practices of the Administration for Building Underground Structures in Moscow] Sovmeshchennaia prokladka truboprovodov; opyt Upravleniia po stroitel'stvu podzemnykh sooruzhenii v Moskve. Moskva, 1959. 20 p. (MIRA 13:6)

1. Akademiya stroitel'stva i arkhitektury SSSR. Institut organizatsii, mekhanizatsii i tekhnicheskoy pomoshchi stroitel'stvu. Byuro tekhnicheskoy informatsii.
(Moscow--Pipelines)

SHAL'NOV, A., kand.tekhn.nauk

Efficient method for laying underground pipelines. Na stroi. Mosk. 2 no.6:8-11 Je '59. (MIRA 12:8)
(Pipelines)

BOGUSLAVSKIY, Leontiy Davidovich; SHAL'NOV, A.P., kand.tekhn.nauk, nauchnyy red.; VLADIMIROVICH, A.G., ~~red.;~~ TOKER, A.M., tekhn.red.

[Reference book for young sanitary technicians] Spravochnik molodogo santekhnika. Moskva, Vses.uchebno-pedagog.izd-vo Proftekhizdat, 1960. 324 p. (MIRA 13:9)
(Plumbing)

MURAV'YEV, I.N., inzh.; SHAL'NOV, A.P., inzh.

New techniques for laying urban underground steel pipelines. Stroi.truboprov. 5 no.1:16-19 Ja '60. (MIRA 13:8)
(Gas, Natural--Pipelines)

SKOBLOV, Georgiy Mikhaylovich; SHAL'NCV, A.P., red.; BUTT, V.P., red. izd-va; LELYUKHIN, A.A., tekhn. red.

[Mechanization of insulation and welding operations in the construction of urban gas pipes] Mekhanizatsiia izoliatsionno-svarochnykh rabot na stroitel'stve gorodskikh gazoprovodov. Moskva, Izd-vo M-va kommun. khoz. RSFSR, 1961. 122 p. (MIRA 14:11)
(Gas pipes)

SHAL'NOV, Anatoliy Petrovich, dotsent, kand.tekhn.nauk; SALYNIN, Ye.A., red.; CHEKRYZHEV, V.A., red.izd-va; POPOVA, S.M., tekhn.red.

[Mechanizing the laying of gas pipes in cities] Mekhanizatsiia prokladki gorodskikh gazoprovodov. Moskva, Izd-vo M-va kommun. khoz.RSFSR, 1961. 129 p. (MIRA 15:2)
(Gas pipes)

SHAL'NOV, A.P., kand. tekhn. nauk; KUZNETSOV, Ye.N., inzh.

Let's improve the organization and technology of building water pipelines in the Virgin Territory. Stroi. truboprov. 7 no.1:5-7 Ja '62. (MIRA 16:7)

(Earthwork)
(Virgin Territory—Water—Distribution)

SKOBLOV, Georgiy Mikhaylovich; KHODKEVICH, Dmitriy Trofimovich; SHAL'NOV, A.P., red.; KOMONOV, A.S., red. izd-va; LELYUKHIN, A.A., tekhn. red.

[Machinery and equipment for the construction of urban gas lines]Mashiny i mekhanizmy dlia stroitel'stva gorodskikh gazoprovodov. Moskva, Izd-vo M-va kommun.khoz.RSFSR, 1962. 136 p. (MIRA 15:8)

(Gas, Natural--Pipelines) (Pipe-laying machinery)

TSITSIN, Petr Georgiyevich; SHAL'NOV, A.P., nauchnyy red.; ZVORYKINA, L.N., red. izd-va; MOCHALINA, Z.S., tekhn. red.

[Application of bituminous coatings on pipes at a plant]Bitumnaia izoliatsiia trub na zavode. Moskva, Gosstroiizdat, 1963. 122 p. (MIRA 16:4)
(Protective coatings) (Pipelines)

SHAL'NOV, Anatoliy Petrovich, kand. tekhn. nauk; SALYNIN, Ye.A., red.; KHENOKH, F.M., tekhn. red.

[Construction of underground urban gas pipe lines] Stroitel'stvo podzemnykh gorodskikh gazoprovodov. Izd.2., perer. Moskva, Izd-vo M-va kommun.khoz.RSFSR, 1963. 302 p. (MIRA 16:11)

(Gas, Natural—Pipelines)

KAPLUN, Yefim Iosifovich; SHAL'NOV, A.P., spets. red.; LYUBINA, M.M., red.

[Handbook for insulation workers on city gas pipelines] Pamiatka dlia izolirovshchika gorodskikh gazoprovodov. Moskva, Stroiizdat, 1964. 46 p. (MIRA 18:2)

[illegible].V, Georgiy Mikhaylovich; SHAL'NOV, A.P., red.

[Directing construction and the organization of work in supplying gas to cities] Upravlenie stroitel'stvom i organizatsiia rabot po gazifikatsii gorodov. Moskva, Stroiizdat, 1964. 159 p. (MIRA 17:8)

APPROVED FOR RELEASE: 08/23/2000 CIA-RDP86-00513R001548420006-1"

KOTOVICH, Fedor Vasil'yevich; SHAL'NOV, A.P., red.

[Organizing technical control in the construction of municipal gasworks] Organizatsiia tekhnicheskogo kontrolia pri stroitel'stve gorodskikh gazovykh setei. Moskva, Stroiizdat, 1965. 82 p. (MIRA 18:4)

SHAL'NOV, A.V.

Experimental investigation of a section of a linear accelerator with phase wave velocity equal to the speed of sound ($\beta = 1$). Nek. vop. inzh. fiz. no.1:58-61 '57. (MIRA 12:5)
(Particle accelerators)

89-6-10/24

AUTHOR ZORIN, D.M., MILOVANOV, O.S., SHAL'NOV, A.V.

TITLE A linearly-cyclic accelerator.
(Lineyno-tsiklicheskiy uskoritel'.- Russian)

PERIODICAL Atomnaya Energiya 1957, Vol 2, Nr 6, pp 552-553 (U.S.S.R.)

ABSTRACT The scheme for which patent rights were applied for by O.A. VALDNER in 1954 under 0608 permits the multiple use of a linear accelerator. Such an accelerator was described as being linearly-cyclic ("elutron"). It operates somewhat like a microtron according to the principle of multiple resonance but it is distinguished from the microtron by the construction of the magnetic system causing rotation. In the case of the elutron discussed here it is possible to use strong magnetic fields and to diminish the weight of the rotation system
The elutron consists of two linear accelerators and of a system of magnetic mirrors. In addition there is an injector, which directs the relativistic electrons to their orbit. The scheme of the elutron is shown in form of a drawing. The magnetic system consists of 4 magnetic mirrors each of which deflects the bundle by 90°. The homogeneous static magnetic

CARD 1/3

89-6-10, 24

A linearly-cyclic accelerator.

field is vertical to the plane of the orbit. If the stray fields are neglected the relativistic particles in the mirror pass through a quadrant with the radius $R = E/eH$. Here $e$ denotes the charge of the electron, $H$ - the magnetic field strength, $E$ - the total energy of the electron. The particles with different energies describe quadrants with different radii in the first mirror and emerge from the mirror as a broad bundle. The second magnetic mirror is inclined by 45° towards the axis of this bundle, deflects the bundles by 45°, and collects the particles of different energies into a narrow bundle. By using a second similar system of magnetic mirrors it is possible to cause particles of different energies to move along closed orbits on the axes of the linear accelerators. The equation for the phase oscillations is similar to the corresponding equation for the microtron. In the here discussed magnetic system a steady motion of particles can be attained by using the focussing properties of the strayfields of the magnetic mirrors and four magnetic quadrupole lenses.
(With 2 Illustrations).

CARD 2/3

89-5-10/24

A linearly-cyclic accelerator.

ASSOCIATION: not given.
PRESENTED BY: -
SUBMITTED: 9.11. 1956.
AVAILABLE: Library of Congress.

CARD 3/3

AUTHORS: Val'dner, O.A., Milovanov, O.S., Tyagunov, G.A., Shal'nov, A.V. 89-7-7/32

TITLE: A Linear Electron Accelerator for 4.5 MeV (Lineynyy elektronnyy uskoritel' na 4.5 Mev)

PERIODICAL: Atomnaya Energiya, 1957, Vol. 3, Nr 7, pp. 41-44 (USSR)

ABSTRACT: The accelerator discussed here has two divided sections for the purpose of being used as elements of a cyclical accelerator. The first section serves as an injector and the second as an accelerating element. The main nodes of the linear accelerator are shown in a schematical drawing. Furthermore, compensation of the defocusing forces is discussed in short. The technical computation of the wave conductor with diaphragm deals with two main problems: with the determination of the geometrical dimensions and with the dynamic of the motion of the electrons in the accelerated system. The initial data for the computation are given. The dynamic of the particles in the accelerated system is computed here by means of Slater's method. The geometrical dimensions were precisely determined with the help of experimentally determined dispersion curves. Experimental Results: Some preliminary operations took place before starting the linear accelerator: The section was tuned to a

Card 1/2

low level of efficiency by means of a measuring generator. After tuning-in of the highfrequency section, injection and focusing of the electron beam was investigated. The coil was adjusted by two methods: provisionally by means of the ray of a centrifuge in the case of a lacking accelerated field, and finally with the help of a ray of accelerated electrons. Next, the parameters of this accelerator were investigated. The energy of the accelerated electrons and their spectrum was determined by means of a spectroscopic analyzer. The spectra recorded by this analyzer are shown in a diagram. The ratio E/E amounts to 6[illegible] and 8[illegible] for the first and second sectors respectively. The investigation of the dependence of the energy of the accelerated electrons in the first section upon the length of the wave produced by the magnetron is also of great interest. Also this dependence is shown in form of a diagram. The accelerator described here was constructed for laboratory use. The results obtained will permit the construction of a more perfect accelerator model. There are 5 figures and 7 references, 0 of which are Slavic.

SUBMITTED: November 9, 1956

AVAILABLE: Library of Congress

Card 2/2 1. Electron accelerators-Design 2. Electron accelerators-Test results 3. Electron accelerators-Equipment

21(9) SOV/112-59-2-3683

Translation from: Referativnyy zhurnal. Elektrotekhnika, 1959, Nr 2, p 207 (USSR)

AUTHOR: Val'dner, O. A., Milovanov, O. S., Tyagunov, G. A., and Shal'nov, A. V.

TITLE: Linear Electron Accelerator 6 Mev (Lineynyy elektronnyy uskoritel' na 6 mev)

PERIODICAL: Izv. vyssh. uchebn. zavedeniy. Radiotekhnika, 1958, Nr 2, pp 222-230

ABSTRACT: The Chair of Electrophysical Outfits, Moscow Engineering-Physics Institute, designed a linear traveling-wave electron accelerator that comprises two sections: the bunching section (accelerating the electrons from 0.4 to 0.97 of the velocity of light), and the accelerating section (bringing the velocity closely to that of light). The sections are connected by a sylphon passing the electrons and by a waveguide matching unit. Ultrahigh-frequency oscillations are derived from a magnetron which is fed by 2.5-microsec pulses with a

Card 1/2

SOV/112-59-2-3683

Linear Electron Accelerator 6 Mev

repetion frequency of 400 cps. Phase shifters are provided at the inputs of both sections. The first section consists of a copper tube (also serving as a vacuumtight envelope) of 90-mm internal diameter; copper diaphragms are secured by the heat-fit method (by liquid-nitrogen cooling). The fosuing coil is slipped over the copper tube. The second section consists of rings held together by longitudinal pins; it has a separate vacuumtight enclosure. The accelerator operates with continuous pumping (seven TsLV-100 pumps, liquid-nitrogen traps). Its current is up to 30 ma; the energy at the first section output is 3.5Mev, and at the second section output, 6.5 Mev. Methods of design, experimental characteristics, and possible applications are indicated. Bibliography: 9 items.

P.K.S.

Card 2/2

89-3-9/30

AUTHORS: Val'dner, O. A., Milovanov, O. S., Tyagunov, G. A., Shal'nov, A. V.

TITLE: A 6 MeV Linear Accelerator for Electrons (Lineynyy elektronnyy uskoritel' na 6 MeV)

PERIODICAL: Atomnaya Energiya, 1958, Vol. 4, Nr 3, pp. 285 - 285 (USSR)

ABSTRACT: The accelerators earlier described (reference 1) were improved so that they can now supply 6 MeV electrons without having made it necessary to increase the high-frequency input power. The improvement was obtained by a redesign of the second section of the accelerator where the velocity of wave propagation is equal to the velocity of light. In this section the radius a of the shutter was decreased so much that $a/\lambda = 0,13$ (earlier it was 0,17). This made possible an increase of the electric field strength along the axis of up to 30 kV/cm. A widening of the spectrum of energy of the accelerated particles was observed as a consequence of the increase of energy (10 % compared with earlier 8 %). There is 1 reference,

Card 1/2

89-3-9/30

A 6 MeV Linear Accelerator for Electrons

1 of which is Slavic.

SUBMITTED: November 18, 1957

AVAILABLE: Library of Congress

1. Electron accelerators-Redesign

Card 2/2

SHAL'NOV, A.V.

21(9) PHASE I BOOK EXPLOITATION SOV/2003

Moscow. Inzhenerno-fizicheskiy institut

Lineynyye uskoriteli; sbornik statey (Linear Accelerators; Collection of Articles) Moscow, 1959. 94 p. 1,000 copies printed.

Ed.: G. A. Tyagunov, Doctor of Technical Sciences, Professor; Tech. Ed.: R. A. Negrimovskaya.

PURPOSE: This collection of articles may be useful to engineers engaged in the development, production and application of linear accelerators.

COVERAGE: The authors discuss the theory and operation of linear accelerators developed by MIFI. They describe methods of measuring variable phase velocity in a waveguide of a linear electron accelerator and discuss ways of determining the diameter of a waveguide. A method of improving the energy spectrum at the output of an accelerator is also discussed. No personalities are mentioned. References appear at the end of each article.

Shal'nov, A. V., and S. P. Lomnev. Preliminary Bunching of Electrons in a Linear Accelerator by Means of a Klystron Resonator 64

The authors study the axial motion of particles in a waveguide resonator of a linear electron accelerator with a klystron preresonator. Methods of analyzing electron bunching are also presented. The authors suggest plotting the output characteristics of a waveguide resonator as a function of output parameters (terminal energy and phase) and the phase of the high-frequency field of a particle entering the klystron resonator. They also present two numerical examples illustrating the advantageous effect of preliminary bunching by means of a klystron. The authors also discuss the injection characteristics of two types of resonators and present the phase-energy characteristics of a klystron resonator. There are 8 references: 5 Soviet, 2 English, and 1 French.

Tragov, A. G. Phase Shifter With Two Dielectric Plates 91

The author discusses a phase shifter in which phase shifting is accomplished by moving two dielectric plates in the cross-section of a rectangular waveguide. It is shown that the use of two plates instead of one makes it possible to increase the phase shift and decrease the size of the phase shifter by one and a half times. Results of theoretical and experimental calculations are presented. There are 2 references, both Soviet.

AVAILABLE: Library of Congress

Card 6/6

JP/lab
8-31-59

3

SHAL'NOV, A.V.

21 (0), 24 (0)

SOV/89-7-2-18/24

AUTHOR: Tyagunov, G. A.

TITLE: Scientific Conference of the MIFI (Nauchnaya konferentsiya MIFI)

PERIODICAL: Atomnaya energiya, 1959, Vol 7, Nr 2, pp 176-177 (USSR)

ABSTRACT: The yearly scientific meeting was held from 17 April to 15 May 1959 in the Moskovskiy inzhenerno-fizicheskiy institut (Moscow Physical Engineering Institute). More than 600 participants from 100 different institutes attended the 2 plenary and 18 sectional conferences. A total of 148 lectures were held. The following lectures are specially mentioned: M. K. Romanovskiy on the thermo-nuclear examinations, N. G. Basov on the physical foundations of molecular generators and amplifiers, A. I. Leypunskiy on the construction of a fast reactor, I. Ya. Pomeranchuk on the theory of the peripheral collision of mesons and nucleons, A. B. Migdal on superfluidity and momentum of inertia of the nuclei, A. S. Kompaneyets on the strong electromagnetic gravity wave, V. I. Gol'danskiy on levels which are excited within the nucleus shell and methods of comprehending them, I. L. Rozental' and L. A. Prokhorova on the analysis of the possible experiments for the determination of the measurements of the μ-mesons, V. I. Dianov-Klokov on the spectrum of liquid and crystalline hydrogen under pressure (8000-10000 atm) and an instrument for measuring the absorption curves, V. A. Lyapidevskiy and O. V. Sinitsydina on new application possibilities of the diffusion chamber, A. V. Shal'nov on calculation methods for linear electron accelerators with migratory waves, P. A. Ryazin, A. B. Mingazin and A. I. Zabayev on new theories of the electron capture under betatron conditions of the acceleration, Ye. G. Pyatnov on optimum wave length for a generator, S. P. Lomnev and G. A. Tyagunov on magnetic focussing in a linear electron accelerator, O. A. Val'dner, P. ... Dmitrovskiy, ... Zorin, Yu. V. ... on the 3 mev linear accelerators of the MIFI, and V. V. Kuznetskiy, O. A. Val'dner, V. V. Katov and Y. N. Chesnokov on examination of the electron movement in the system of the eletron with consideration of the scattering fields, O. A. Krayev on impulse method for measuring the heat conduction capacity of liquids and the theory of this method, Ya. ... Khabakhpashev, Yu. L. Il'in and S. A. Chirov on heat transmission to the eutectic Na-K which flows in a circular space, V. I. Petrovichev on heat transmission to circulating mercury, ... Roysin on special conditions when working with a flat triode in

Card 1/3

the impulse technique, O. S. Poturayev on calculation methods and construction of an impulse transformer for instruments with semi-conductor elements, Ya. A. Chetaruev on a possibility judge the characteristics of magnetic recording of impulses, B. I. Kal'nin on the element system for a universal digital computer, V. S. Malov on multiple control of the parameters of technologic processes, P. I. Popov on analysis of several systems with which physical energy apparatus can be automatically started, Yu. I. Topchayev on a method to examine the quality of a reactor control when the reactivity changes stepwise or linearily, G. A. Leont'yev and A. I. Yevstyukhin on examination of the iodine method of refining niobium and characteristics of the metal obtained, P. L. Gruzin and G. G. Ryabova on examination of the micro-distribution of carbon, tungsten, iron and other elements in zirconium and its alloys by use of auto-radiography, G. B. Fedorov on determination of the sublimation heat of zirconium and nickel by using radioactive indicators and G. B. Fedorov and A. N. Semenikhin on determination of the diffusion coefficients of chromium, nickel, iron and chromium nickel steels. The literature for all these lectures will be published by the MIFI in a symposium.

Card 2/3

Card 3/3

24387

S/142/60/003/005/014/015
E192/E382

9,1300

AUTHOR: Shal'nov, A.V. and Sobenin, N.P.

TITLE: Selective Characteristics of a Disc-loaded Waveguide

PERIODICAL: Izvestiya vysshikh uchebnykh zavedeniy, Radiotekhnika, 1960, Vol. 3, No. 5, pp. 524 - 529

TEXT: In the investigation of the frequency stability of a supply source feeding a linear electron accelerator, it is necessary to know the relationship between the changes of the phase velocity in a disc-loaded waveguide and the frequency changes. The solution of the problem can be based on the scattering equation which relates the geometric parameters of the waveguide to the frequency. However, equations of this type (Ref. 1 - E.L. Chu, W.W. Hansen - J. Appl. Phys., 1947, Vol. 18, No. 11; Ref. 2 - W. Walkinskaw - Phys. Soc., 1948, Vol. 61, No. 2, 246; Ref. 3 - W. Walkinskaw - J. Appl. Phys., 1949, Vol. 20, No. 6) cannot be solved explicitly with respect to phase velocity. It is therefore convenient to employ for this purpose the Grojean--Vanhuyse formula (J1, Nuwo Cimento, 1955, Vol. 1, No. 1 - Ref. 5), which is valid for a wide range

Card 1/10

of geometrical parameters of a disc-loaded waveguide. This formula is:

$$f = f_{\frac{\pi}{2}} - \frac{f_\pi - f_0}{2}\cos\Theta + \frac{f_\pi + f_0 - 2f_{\frac{\pi}{2}}}{2}\cos^2\Theta, \quad (1)$$

where $\Theta = kD/\beta$ is the phase shift in an element or cell of the waveguide,
$\beta$ is the phase velocity of the wave in light velocity units,
$k$ is the wave number,
$D$ is the period of the waveguide, and
$f_0, f_{\pi/2}, f_\pi$ are the oscillation frequencies of the 0, $\pi/2$ and $\pi$ modes, respectively.

The frequencies $f_0$, $f_{\pi/2}$ and $f_\pi$ can be best determined from the parametric curves which are considered in this paper. It was shown by W. Walkinskaw (Ref. 2) that the scattering

equation for the oscillations of the $\pi/2$-mode can be represented in a parametric form as:

$$\frac{1}{1-\zeta}\cdot\frac{1}{ka}\frac{F_1(ka)}{F_0(ka)}=\sum_{m=-\infty}^{+\infty}\frac{1}{\gamma_m a}\cdot\frac{I_1(\gamma_m a)}{I_0(\gamma_m a)}\cdot I_0\left(\frac{\gamma_m d}{2}\right)\frac{\sin\frac{\gamma_m d}{2}}{\frac{\gamma_m d}{2}}, \qquad (2)$$

where:

$$F_1(ka)=I(ka)N_0(kb)-N_1(ka)I_0(kb);$$
$$F_0(ka)=I_0(ka)N_0(kb)-N_0(ka)I_0(kb); \qquad (2a)$$

where $a$ is the radius of the aperture in the discs of the waveguide,
$b$ is the internal radius of the waveguide,
$\zeta D$ is the thickness of a disc,
$I_n$ is a Bessel function of the n-th order of the first kind,
$N_n$ is a Bessel function of the n-th order of the second kind, and:

24387

S/142/60/003/005/014/015
E192/E382

Selective Characteristics ....

$$\gamma_m = \gamma_0 + \frac{2\pi m}{D}; \quad \gamma_0 = \frac{k}{\beta}; \quad \varkappa_m^2 = k^2 - \gamma_m^2. \qquad (2b)$$

Since for the $\pi/2$-mode $D = \beta\lambda/4$ and $\gamma_m = k/\beta(1 + 4m)$, Eq. (2) can be written as:

$$\frac{F_1(ka)}{F_0(ka)} = \sum_{m=-\infty}^{+\infty} \frac{\beta}{\sqrt{\beta^2 - (1+4m)^2}} \frac{I_1\left[ka\sqrt{1-\left(\frac{1+4m}{\beta}\right)^2}\right]}{I_0\left[ka\sqrt{1-\left(\frac{1+4m}{\beta}\right)^2}\right]} \times$$
$$\times \frac{I_0\left[\frac{\pi}{4}(1+4m)(1-\zeta)\right]\sin\left[\frac{\pi}{4}(1+4m)(1-\zeta)\right]}{\frac{\pi}{4}(1+4m)}. \qquad (3)$$

From the above it is seen that the scattering curves, calculated by taking an arbitrary number of the terms in the righthand-side portion of Eq. (3), depend on the combination of the quantity ka, kb and $\beta$. Consequently, it is seen that the

Card 4/10

24387

S/142/60/003/005/014/015
E192/E382

Selective Characteristics ....

scattering equation can be represented in the form $ka = f(kb)$ with $\beta$ as a parameter or $ka = \varphi(\beta)$ as a parameter. For the zero mode, $\gamma_o = 0$ and $\gamma_m = 2\pi m/D$. In this case, the scattering equation is:

$$\frac{F_1(k_0a)}{F_0(k_0a)} = \sum_{m=-\infty}^{+\infty} \frac{1}{\sqrt{1-\left(\frac{4m}{\beta\frac{k_0}{k}}\right)^2}} \cdot \frac{I_1\left[k_0a\sqrt{1-\left(\frac{4m}{\beta\frac{k_0}{k}}\right)^2}\right] I_1[\pi m(1-\zeta)]\sin[\pi m(1-\zeta)]}{I_0\left[k_0a\sqrt{1-\left(\frac{4m}{\beta\frac{k_0}{k}}\right)^2}\right]\pi m} \quad (4) \qquad (4)$$

where $k_o$ is the wave number for the zero mode. For the $\pi$-mode, the scattering equation becomes:

Card 5/10

24387

S/142/60/003/005/014/015
E192/E382

Selective Characteristics ....

$$\frac{F_1(k_\pi a)}{F_0(k_\pi a)} = \sum_{m=-\infty}^{+\infty} \frac{1}{\sqrt{1-\left[\frac{2(1+2m)}{\beta\frac{k_\pi}{k}}\right]^2}} \times$$

$$\times \frac{I_1\left[k_\pi a\sqrt{1-\left[\frac{2(1+2m)}{\beta\frac{k_\pi}{k}}\right]^2}\right] I_0\left[\frac{\pi}{2}(1+2m)(1-\zeta)\right]\sin\left[\frac{\pi}{2}(1+2m)(1-\zeta)\right]}{I_0\left[k_\pi a\sqrt{1-\left[\frac{2(1+2m)}{\beta\frac{k_\pi}{k}}\right]^2}\right]\frac{\pi}{2}(1+2m)} \quad (5)$$

From the above it is seen that for the 0- and π-modes the scattering equation can also be represented in a parametric form. Consequently, if the geometric dimensions of a cell of the waveguide, the phase velocity of the wave and the wave number for the π/2-mode are known, it is possible to determine

Card 6/10

Eq (5) on page 517 attached to Mat 6

24387
S/142/60/003/005/014/015
E192/E382

Selective Characteristics ....

the frequency of the 0- and π-oscillation modes. The parametric curves obtained experimentally for 0-, π/2- and π-modes are shown in Figs. 1-3, respectively. The curves were obtained by measuring the frequencies of 0-, π/2- and π-oscillation modes in a resonator formed by a single cell and two semi-cells of a disc-loaded waveguide (Ref. 5). From the curves of Fig. 1 it is possible to determine the frequency at which the oscillations of the π/2-mode occur in a cell. Similarly from Figs. 2 and 3 it is possible to find the frequencies of the 0- and π-oscillation modes. The maximum error in determining the frequencies of 0- and π-modes does not exceed 1.7%. There are 3 figures, 1 table and 6 references: 2 Soviet and 4 non-Soviet. The English-language references are quoted in the text.

Card 7/10

24387

S/142/60/003/005/014/015
E192/E382

Selective Characteristics ....

ASSOCIATION Glavnoye Upravleniye po ispol'zovaniyu atomnoy energii pri Sovete Ministrov SSSR (General Commission on Utilisation of Atomic Energy Attached to the Council of Ministers of the USSR)

SUBMITTED February 15, 1960 (initially)
April 4, 1960 (after revision)

Card 8/10

25816

24.6731

S/142/60/003/006/006/016
E032/E114

AUTHORS: Shal'nov, A.V., and Glazkov, A.A.

TITLE: Some problems in the design of linear electron accelerators

PERIODICAL: Izvestiya vysshikh uchebnykh zavedeniy, Radiotekhnika, 1960, Vol.3, No.6, pp. 598-604

TEXT: A description is given of simplified methods for the analysis of the relation between the electron energy and the phase velocity on the one hand and the supply frequency on the other, when there are small departures from the nominal value of the frequency. The exact analysis of linear electron accelerations is very complicated and is based on the numerical integration of the equation of motion with varying frequency (A.V. Shal'nov, Ye.G. Pyatnov and A.A. Glazkov, Sb. tr. MIFI, "Lineynyye uskoriteli", Moscow, 1959, Ref.1). The present methods are not exact but they are convenient for practical purposes. The first method is based on the assumption that at the end of the accelerator the electron velocity is equal to the phase velocity of the wave. This method is applied to accelerators with

X

Card 1/3

25816

Some problems in the design of .... S/142/60/003/006/006/016
E032/E114

adiabatic (slow) increase in the phase velocity along the wave-guide. The second method is convenient with electron linear accelerators in which the phase velocity increases very rapidly over a small initial part of the waveguide. In this method use is made of the relation between the change in the particle energy and the phase shift at the end of the accelerator. Formulae are derived which can be used to obtain a rapid and relatively accurate estimate of the frequency properties of linear accelerators. The second part of the paper is concerned with approximate expressions for the group velocity of the wave. A derivation is given of a set of equations for the group velocity as a function of the geometry of the waveguide and the working parameters. This formula is said to be more accurate and more general than those given by V. Vladimirskiy (Ref.5: DAN SSSR, 1946, V.52, 3, 219) and E. Chu and W. Hansen (Ref.6: The Theory of Dise - Loaded Wave Guides. J. App. Phys., 1948, V.18, No.11, 996).
There are 1 figure and 7 references: 2 Soviet and 5 non-Soviet.
The four most recent English language references read as follows:
Ref.2: R. Shersby, Harvie - Travelling wave Linear Electron
Accelerator. Proc. Phys. Soc., 1948, V.61, Pt.III, No.345, p.255.

Card 2/3

25816

Some problems in the design of .... S/142/60/003/006/006/016
E032/E114

Ref.4: C. Grosjean, V. Vanhuyse. "Experimental Verification of a Frequency Equation for Corrugated Wave Guides" II, Nuovo Cimento, 1955, Vol.1, No.1, 193.
Ref.6: as quoted in the text above.
Ref.7: W. Walkinshaw. "Theoretical Design of a Linear Accelerator for Electrons". Proc. Phys. Soc., 1948, V.61, Pt. III, No.345, 246.

ASSOCIATION: Kafedra elektrotekhniki Moskovskogo inzhenerno-fizicheskogo instituta (Department of Electrical Engineering, Moscow Engineering and Physics Institute)

SUBMITTED: Initially July 24, 1959, and after revision January 6, 1960.

X

Card 3/3

24.6731 (4217)
9.3130 (1163, 1532, 1538)

S/141/61/004/002/010/017
E032/E114

AUTHORS: Shal'nov, A.V., and Gavrilov, N.M.

TITLE: The effect of frequency deviations on the output energy in a linear electron accelerator

PERIODICAL: Izvestiya vysshikh uchebnykh zavedeniy, Radiofizika, 1961, Vol.4, No.2, pp. 306-308

TEXT: The equations of motion of electrons in a linear accelerator are of the form:

$$\frac{dW}{dz} = eE(z)\cos\varphi(z), \qquad \frac{d\varphi}{dz} = \frac{2\pi}{\lambda}\left(\frac{1}{\beta_B} - \frac{1}{\beta_э}\right) \qquad (1)$$

(R.B. Neal, J Appl. Phys., Vol.29, 1019 (1958), Ref.1),

where: $\beta_э = \sqrt{1 - (W_o/W)^2}$, $W_o$ is the rest energy, $W$ is the total energy, $E(z)$ is the amplitude of the electric field, $\varphi(z)$ is the electron phase relative to the wave, and $\beta_B$ and $\beta_э$ are the phase velocity of the wave and the electron velocity (in units of $c$). In the case of relativistic electrons it may be assumed that an increase in the energy is not accompanied by an appreciable change in the velocity, i.e. $\beta_э \sim 1$. If the phase

Card 1/6

velocity of the wave approaches the velocity of light, then it follows from Eq.(1) that the phase of the electron relative to the wave is independent of $z$. When the applied frequency changes owing to instabilities in the high-frequency source, the phase velocity of the accelerating electromagnetic wave also changes ($\beta_B \neq 1$). In this case the right-hand side of the second equation in Eq.(1) becomes a constant and integration yields $\varphi = \varphi_o + kz$. The relative change in the energy when the frequency departs from its nominal value is calculated from the expression

$$\frac{\Delta W}{W} = \frac{W - W_1}{W} \tag{2}$$

where $W$ is the energy corresponding to the nominal frequency and $W_1$ is the energy corresponding to the modified frequency. In order to calculate $W_1$ it is necessary to determine the variation of the field amplitude with $z$ using the power balance equation

$$-\frac{dP}{dz} = 2\alpha P + IE(z)\cos(\varphi_o + kz) \tag{3}$$

where $\alpha$ is the attenuation coefficient in the diaphragmed wave-

guide. $I$ is the current, $P$ is the high-frequency power; and $k = \Delta\varphi/z$. The latter equation can easily be transformed into the following equation for the field amplitude:

$$-\frac{dE}{dz} = I\alpha\eta \cos(kz) + \alpha E \qquad (4)$$

Integrating this equation with the initial conditions $E(z) = E_o$ when $z = 0$, it is found that

$$E(z) = \left(E_o + \frac{I\alpha^2\eta}{\alpha^2 + k^2}\right)e^{-\alpha z} - \frac{I\alpha\eta}{\alpha^2 + k^2}\left[\alpha \cos(kz) + k \sin(kz)\right] \qquad (5)$$

In order to determine $W_1$ use is made of the first equation in Eq.(1) in conjunction with Eq.(5) and the final result is

$$W_1 = ez\left\{\left(E_o + \frac{I\eta x^2}{x^2 + y^2}\right)\left[\frac{e^{-x}}{x^2 + y^2}(y \sin y - x \cos y) + \frac{x}{x^2 + y^2}\right] - \right.$$
$$\left. - \frac{I\eta x^2}{2(x^2 + y^2)}\left[1 + \frac{1}{2y}\sin(2y)\right] - \frac{1}{2}\frac{I\eta x^2}{x^2 + y^2}\sin^2 y\right\} \qquad (7)$$

where $x = \alpha z$, $y = kz = \Delta\varphi$. It is then easy to show that the approximate expression for the relative change in the energy is of the form

$$\Delta W/W = By^2/6 \tag{12}$$

where

$$B = \frac{2x(3A - x^2) + 3\left[(x - 1)^2 - e^{-x}\left\{Ax\left[(x + 1)^2 + 1\right] + (x+1)^2 + 3\right\}\right]}{x^2\left[(Ax + 1)(1 - e^{-x}) - x\right]} \lessgtr 1 \tag{13}$$

Eq.(13) is plotted in Fig.1. When I = 0, Eq.(12) reduces to

$$\frac{\Delta W}{W} = \frac{y^2}{6}\left[\frac{6}{x^2} - \frac{3 + 6/x}{e^x - 1}\right]$$

which is in agreement with the formula published by M. Chodorov et al. (Ref.2: M. Chodorov, E. Ginzton, W. Hausen, R. Keal, R. Neal, W. Panofsky. Rev. Sci. Instr., Vol.26, 131 (1955)).
There are 1 figure and 2 English references, which read:

Ref.1: R.B. Neal, J. Appl. Phys., Vol.29, 1019 (1958).
Ref.2: as quoted in the text above.

The effect of frequency deviations... S/141/61/004/002/010/017
E032/E114

ASSOCIATION: Moskovskiy inzhenerno-fizicheskiy institut
(Moscow Engineering and Physics Institute)

SUBMITTED: July 9, 1960

Card 5/6

TYAGUNOV, Georgiy Aleksandrovich. Prinimali uchastiye: ZHIGAREV, A.A., kand. tekhn. nauk; VAL'DNER, O.A., kand. tekhn. nauk; SHAL'NOV, A.V., kand. tekhn. nauk; CHISTYAKOV, P.N., kand. tekhn. nauk; YUDINSKAYA, I.V., starshiy prepodavatel'; FRIDKIN, A.M., tekhn. red.

[Electron-tube and transistor devices (physics, fundamental theory, and principal designs)] Elektrovakuumnye i poluprovodnikovye pribory (fizika, elementarnaia teoriia, osnovnye konstruktsii). Moskba, Gos. energ. izd-vo, 1962. 398 p. (MIRA 15:4)

(Electron tubes) (Transistors)

40995

S/058/62/000/009/003/069
A006/A101

246731

AUTHORS: Gavrilov, N. M., Shal'nov, A. V.

TITLE: Approximate analytical method of calculating the phase-energy electron distribution in a linear electron accelerator with $\beta_B = 1$

PERIODICAL: Referativnyy zhurnal, Fizika, no. 9, 1962, 4, abstract 9B43 (In collection: "Uskoriteli", no. 3, Moscow, Gosatomizdat, 1962, 39 - 43)

TEXT: In order to determine analytically the characteristics of an accelerated beam at the outlet of a section with $\beta_B = 1$, it is assumed that all the electrons (independent of the initial conditions) "slide" linearily along the phase in respect to the wave: $\varphi(z) = \varphi_0 - kz$, where $\varphi_0$ is the initial electron phase in a section with $\beta_B = 1$, k is the coefficient of proportionality, characteristic of the slip rate. In this case the integration of equations of the (longitudinal) electron motion and the determination of their initial energy is not difficult. To illustrate the method, phase-energy distributions for 10- and 30-Mev accelerators are calculated; the results obtained are in a satisfactory agreement with calculated data.

S. Semenov

[Abstracter's note: Complete translation]

Card 1/1

S/058/62/000/009/041/069
A006/A101

AUTHOR: Shal'nov, A. V.

TITLE: An engineering scheme for calculating a diaphragmed waveguide of a linear electronic accelerator

PERIODICAL: Referativnyy zhurnal, Fizika, no. 9, 1962, 21, abstract 9Zh127 (In collection: "Uskoriteli", no. 3, Moscow, Gosatomizdat, 1962, 136 - 140)

TEXT: The author presents and describes a detailed calculation system for determining the parameters of a diaphragmed waveguide depending on the outlet parameters of the beam (energy, spectrum, width of phase cluster). Losses in the waveguide metal, the beam current, and non-stability of the feed source are taken into account.

G. Zhileyko

[Abstracter's note: Complete translation]

Card 1/1

S/058/62/000/010/015/093
A061/A101

AUTHORS: Ogorodov, Yu. V., Ogorodova, I. K., Shal'nov, A. V.

TITLE: The use of an electronic simulator for the solution of equations of longitudinal electron motion in the linear accelerator

PERIODICAL: Referativnyy zhurnal, Fizika, no. 10, 1962, 6, abstract 10B49 (In collection: "Uskoriteli", no. 3, Moscow, Gosatomizdat, 1962, 44 - 53)

TEXT: Described is a universal simulator MH - M (MN-M) for the solution of equations of longitudinal particle motion in the buncher of a linear accelerator for a given change (along the accelerator axis) of the phase velocity of a wave and of the accelerating field amplitude. The difficulties arising in the simulation are considered, and a block diagram of the device is given. The results from the simulation of two versions of the problem, preliminarily computed on a БЭСМ (BESM) electronic computer, are presented. As is shown, the error in determining the phase angle does not exceed 2%, while the maximum error in the

Card 1/2

S/058/62/000/010/015/093
A061/A101

T ...rator for...

el... determination is 3%. The principal merit of the apparatus is its simple "re-a...



S. Semenov

[Abstracter's note: Complete translation]

Card 2/2

S/058/62/000/010/017/093
A061/A101

AUTHORS: Gavrilov, N. M., Lomnev, S. P., Milovanov, O. S., Pyatnov, Ye. G., Tyagunov, G. A., Shal'nov, A. V.

TITLE: Exit parameters and working characteristics of linear electron accelerators

PERIODICAL: Referativnyy zhurnal, Fizika, no. 10, 1962, 6, abstract 10B51 (In collection: "Uskoriteli", no. 3, Moscow, Gosatomizdat, 1962, 75 - 82)

TEXT: The working characteristics, obtained with the БЭСМ (BESM) electronic computer, of 2 - 25 Mev linear electron accelerators developed at MIFI, are presented. By working characteristics are meant the different dependences of the exit parameters of the accelerator (maximum energy, width of the energy spectrum, phase width of clusters) on the energy and flux of injected particles, as well as on the frequency and power of the h-f feed.

V. Kanunnikov

[Abstracter's note: Complete translation]

Card 1/1

S/194/62/000/011/032/062
D413/D308

AUTHORS: Gavrilov, N. M. and Shal'nov, A. V.

TITLE: An approximate analytical method for calculating the phase-energy distribution of electrons in a linear electron accelerator with $\beta_B = 1$

PERIODICAL: Referativnyy zhurnal, Avtomatika i radioelektronika, no. 11, 1962, 39, abstract 11-3-78a (In collection: Uskoriteli, M., Gosatomizdat, no. 3, 1962, 39-43)

TEXT: An approximate analytical method is given for calculating the phase-energy distribution of electrons in a linear electron accelerator with $\beta_B = 1$. It is shown that existing analytical techniques are inapplicable for obtaining the output characteristics of the accelerated beam. In order to assess the accuracy of the proposed method, the phase-energy distributions were taken for two accelerators with energies 10 MeV and 30 MeV, and they showed satisfactory agreement with the values calculated from the approximate for-

Card 1/2

mula and using numerical integration. A certain divergence is explained. It is pointed out that a relatively large divergence between the energy values obtained by numerical integration and from the approximate formula has no material effect on the form of the output energy spectrum. Graphs are given and explained for the phase-energy distribution at the output of the 10 MeV and 30 MeV accelerators. 2 references. [Abstracter's note: Complete translation.]

S/058/62/000/011/047/061
A160/A101

AUTHORS: Ogorodov, Yu. V., Ogorodova, I. K., Shal'nov, A. V.

TITLE: The use of an electronic simulator for solving equations of the longitudinal motion of electrons in a linear accelerator

PERIODICAL: Referativnyy zhurnal, Fizika, no. 11, 1962, 40 - 41, abstract 11-3-80u (In collection: "Uskoriteli". no. 3. Moscow, Gosatomizdat, 1962, 44 - 53)

TEXT: To obtain the characteristics of an accelerated electron beam, it is necessary to solve the equations characterizing the longitudinal motion of particles with the given modes of $U_B$ (z) and Eo (z) variation. The solution of this system of equations was carried out on a universal simulator designed for computing the bunchers of commercial-type electron accelerators. Considered are the main difficulties of electrical simulating the functions which become a part of the system of the motion equations, and also the various receptions permitting to decrease errors in the results. A block diagram of the simulation of the system of motion equations is presented, and the main operational processes

Card 1/2

of its individual units are considered. A comparison of the final results of the simulation with the numerical solution obtained at the BESM reveals that the error in determining the magnitude of the phase angle does not exceed 2%, and that the maximum error in determining the energy is 3%. Comparative tables of the end phases and ultimate energies for the corresponding initial phases are furnished. It is noted that the simplicity of readjusting the circuit to the new variant, and also the clearness of the obtained results, may be considered the main merits of the investigated method for solving the system of the motion equations.

V. K.

[Abstracter's note: Complete translation]

S/194/62/000/011/030/062
D413/D308

AUTHOR: Shal'nov, A. V.

TITLE: An engineering design calculation scheme for a septate waveguide in a linear electron accelerator

PERIODICAL: Referativnyy zhurnal, Avtomatika i radioelektronika, no. 11, 1962, 37, abstract 11-3-74f (In collection: Uskoriteli, M., Gosatomizdat, no. 3, 1962, 136-140)

TEXT: Schemes are given for the design calculation for a septate waveguide in a linear electron accelerator. They allow one to determine the basic characteristics of the electron beam at the output of the accelerator and to estimate the stability of these characteristics with time. They have been used in the design of production accelerators with 3 and 5 MeV energy. There is satisfactory agreement between the theoretical and experimental characteristics of the accelerated beam. The calculations enable one to determine the effect of the geometrical dimensions of the septate waveguide on the characteristics of the accelerated beam. This

Card 1/2

An engineering design ... S/194/62/000/011/030/062
D413/D308

technique of computation can also be applied to accelerators designed for greater energies. 1 reference. [Abstracter's note: Complete translation.]

Card 2/2

S/759/62/000/004/001/016
D207/D308

AUTHORS: Val'dner, O. A., Koroza, V. I. and Shal'nov, A. V.

TITLE: On the problem of the possibility of wide-range energy regulation in linear electron accelerators - bunchers

SOURCE: Moscow. Inzhenerno-fizicheskiy institut. Uskoriteli, no. 4, 1962, 3-6

TEXT: An accelerator with continuous output energy variation is required for some applications in physics and chemistry. For a short accelerator such an energy variation is best obtained by varying the frequency of the microwave power supply. To vary the energy of a pulsed 200 mA electron beam with the range 1 - 2 MeV it is necessary to: (1) select the accelerating system so that it gives the required energy variation within a specified frequency range without too much broadening of the energy spectrum; (2) ensure satisfactory working of the microwave source within the specified frequency range. The present paper deals only with the first

Card 1/2

S/759/62/000/004/001/016
D207/D308

On the problem of ...

point. It is shown that using a $\lambda = 10.5$ cm 1.5 MW source of microwave pulses an energy variation from 1.3 to 2.1 MeV may be obtained by varying the source frequency by 10 Mc/s; the width of the energy spectrum under these conditions does not exceed 18%. There are 3 figures.

Card 2/2

S/759/62/000/004/002/016
D207/D308

AUTHORS: Val'dner, O. A., Koroza, V. I. and Shal'nov, A. V.

TITLE: Use of untunable magnetrons for power supplies of linear electron accelerators

SOURCE: Inzhenerno-fizicheskiy institut. Uskoriteli, no. 4, 1962, 7-11, Moscow

TEXT: The use of untunable magnetrons in power supplies of linear electron accelerators gives the advantages of lower cost, longer service life and higher available power, compared with tunable magnetrons. The present paper deals with problems caused by frequency deviations from the nominal value in mass-produced untunable magnetrons. A corrugated waveguide used in conjunction with a magnetron should be designed so that the frequency deviation in the latter does not greatly affect the energy and spectrum of the accelerated electrons. Design calculations are given for the following accelerator model, called У-20 (U-20): a circular waveguide with a parameter $a/\lambda = 0.3$, accelerator length 2 m; here a is the

Card 1/2

Use of untunable ... S/759/62/000/004/002/016
D207/D308

radius of apertures in the diaphragms of the corrugated waveguide and $\lambda$ is the working wavelength. The calculations were carried out on an analog computer and they showed that, under certain specified conditions, a satisfactory electron-energy peak is obtained at 5 MeV. The authors consider also the frequency dependence of the electron energy for an accelerator of У-12 (U-12) and show that its large microwave power margin (only 25% of the power is used for electron acceleration) can be used to increase the beam current. There are 6 figures.

Card 2/2

S/759/62/000/004/010/016
D207/D308

AUTHORS: Milanov, O. S. and Shal'nov, A. V.

TITLE: Determination of the operational stability of a magnetron with a frequency-dependent load such as the high-frequency channel of a linear electron accelerator

SOURCE: Moscow. Inzhenerno-fizicheskiy institut. Ukoriteli, no. 4, 1962, 86-94

TEXT: A simple method is given for analyzing the operation of a magnetron feeding a low-energy (3 - 10 MeV) linear electron accelerator. An equivalent circuit of the magnetron and its load is employed to obtain load-matching criteria ensuring stability, within specified limits, of the magnetron working frequency. Polar impedance diagrams (Smith charts) are used and calculations of the bandwidths within which the magnetron is stable agree with the experimental values for accelerators У-2 (U-2), У-10/I (U-10/I), У-10/II (U-10/II) and У-IM (U-IM). There are 5 figures and 1 table.

Card 1/1

S/759/62/000/004/011/016
D207/D308

AUTHORS: Milovanov, O. S. and Shal'nov, A. V.

TITLE: Frequency drift of a magnetron loaded with the high-frequency channel of a linear electron accelerator

SOURCE: Moscow. Inzhenerno-fizicheskiy institut. Uskoriteli, no. 4, 1962, 95-100

TEXT: The following causes of the frequency drift of a magnetron in linear accelerator are considered: (1) changes of the load temperature which alter the load input impedance, (2) mains voltage fluctuations which alter the injected electron beam parameters (and thus the load impedance) as well as the operating conditions of the magnetron itself, (3) changes of temperature of the cooling water circulating around the magnetron. It is shown that for a 3 MeV accelerator fed from a $\lambda = 10$ cm magnetron the maximum frequency drift does not exceed $\approx 0.1$ Mc/s for 1% change in the mains voltage or 1°C change in the load temperature. This drift has to be allowed for only in accelerators with a strong depen-

Card 1/2

Frequency drift of a ... S/759/62/000/004/011/016
D207/D308

dence of the phase velocity in the load on the magnetron operating frequency. There is 1 figure.

Card 2/2

S/759/62/000/004/013/016
D207/D308

AUTHORS: Sobenin, N. P. and Shal'nov, A. V.

TITLE: Dependence of the electron output energy on the dimensional tolerances of a linear accelerator waveguide

SOURCE: Moscow. Inzhenerno-fizicheskiy institut. Uskoriteli, no. 4, 1962, 103-110

TEXT: To determine the dependence referred to in the title the authors plotted first parametric curves of the derivatives of the phase velocity ß in a corrugated waveguide with respect to the following geometrical dimensions: the radius of the apertures in the diaphragms (corrugations), a; the inner radius of the waveguide itself, b; the distance between the diaphragms, d; the thickness of the diaphragms, t. The ratio a/b was used as the parameter and the curves were derived from the experimental partial derivatives of the $\pi/2$-mode frequency with respect to the waveguide dimensions and from group velocity values. It was found that the dimension b had the greatest effect on the phase velocity ß, and

Card 1/2

S/759/62/000/004/013/016
D207/D308

Dependence of the ...

that a, d, t affected ß less. From the frequency dependence of the energy of electrons produced by a 3 MeV accelerator of Y-10 (U-10) type, it was found that for the energy not to vary by more than 5 or 10% from the nominal value, the waveguide dimension tolerances must be within 20 or 50 μ, respectively. For a particular buncher a 20 μ tolerance in dimensions was found to result in a 1% departure from the nominal electron output energy. There are 4 figures and 1 table.

Card 2/2

APPROVED FOR RELEASE: 08/23/2000 CIA-RDP86-00513R001548420006-1"

S/759/62/000/003/004/021

AUTHORS: N. M. Gavrilov and A. V. Shal'nov

TITLE: Approximate analytic method of calculating the phase-energy electron distribution in a linear electron distribution with $\beta_0 = 1$

SOURCE: Moscow. Inzhenerno-fizicheskiy institut. Uskoriteli. no.3.1962. 39-43.

TEXT: Previous methods of analytically obtaining the output characteristics of an accelerated beam have serious shortcomings in that either the field is assumed constant along the length of the accelerator, or else the fact that the electron falls behind the traveling wave is not taken into account. By assuming that the electron lags the wave in phase in a linear fashion and by all particles, regardless of the initial conditions, exhibit the same linear lag, it becomes possible to integrate the equations of motion of particles in the region of the linear accelerator where the phase velocity is constant and equal to the velocity of light. The agreement between the proposed equation and the results of numerical computations is satisfactory, for although the differences in the resulting energies are large, the resultant energy spectra are of similar shape, which is the more important factor.

Card 1/1

S/759/62/000/003/005/021

AUTHORS: Ogorodov, Yu. V., Ogorodova I. K., Shal'nov, A. V.

TITLE: Use of electronic analog to solve the equations of longitudinal electron motion in a linear accelerator.

SOURCE: Moscow. Inzhenerno-fizicheskiy institut. Uskoriteli. no.3. 1962. 44-53

TEXT: An attempt is described of using general-purpose analog computers to solve the system of equations of motion of electrons in a linear accelerator. Although the system can be solved more accurately with digital computers, the programming of the latter is complicated and the resultant digital data have to be further processed longhand. The type of accelerator for which the analog is used is first described, followed by a discussion of the difficulties entailed in the simulation of the system. A block diagram of the analog is then presented and described. To explain the possibilities of electric analog simulation and to check on the proposed procedure for the solution of the system of equations, several variants of the problem have been solved both on the BESM digital computer and on the Mn-M general-purpose analog computer. The results are compared.

Card 1/2

S/759/62/000/003/005/021

Use of electronic analog ...

It is concluded that the method proposed has several advantages, major among which are the simplicity resetting the analog from variant to variant, and the perspicuous manner in which the final results are displayed. The work was done under the guidance of O. A. Val'dner and I. M. Vitenberg. There are two tables and one block diagram. Reference is made by a paper on a similar device by Demos (Ref. 5. Rev. Scient. Instrum. vol. 30, no. u, 543 (1959).)

Card 2/2

S/759/62/000/003/013/021

AUTHOR: Shal'nov, A. V.

TITLE: Procedure scheme for engineering design of the iris waveguide of a linear electron accelerator

SOURCE: Moscow. Inzhenerno-fizicheskiy institut. Uskoriteli. no.3. 1962. 136-140

TEXT: A design procedure was worked out at the Moscow Engineering-physics institute for the main unit of the series of 3 -- 10 MeV accelerators being readied for regular production. The first stage of the design consists of determining the variation of the field intensity and of the relative phase velocity along the accelerator. The second stage is determination of the geometrical dimensions of the iris waveguide and its end product is a table of those dimensions that realize the chozen variations of the relative field intensity and relative phase velocity along the accelerator. The third stage consists of determining the effect of instability of the power sources on the characteristics of the accelerated beam. The use of this scheme of calculations for the 3 and MeV accelerators has yielded good agreement with experiment. There is one figure.

Card 1/1

VAL'DNER, Oleg Anatol'yevich; SHAL'NOV, Aleksandr Vsevolodovich; MEL'NIKOVA, A.I., red.; VLASOVA, N.A., tekhn. red.

[Electromagnetic fields in septate wave guides of electron accelerators] Elektromagnitnye polia v diafragmirovannykh volnovodakh lineinykh elektronnykh uskoritelei. Moskva, Gosatomizdat, 1963. 65 p. (MIRA 17:1)

ZENKEVICH, P.R.; SHAL'NOV, A.V.

Selection of the feeding pattern and calculation of the variational characteristics of 10-15 Mev. linear accelerators with reversible power input. Uskoriteli no.5:75-90 '63. (MIRA 17:4)

ACCESSION NR: AT4019724 S/2759/63/000/005/0075/0090

AUTHOR: Zenkevich, P. R.; Shal'nov, A. V.

TITLE: Choice of a feed system and calculation of the variational characteristics of linear accelerators of energies of 10 and 15 Mev with power feedback input

SOURCE: Moscow. Inzhenerno-fizicheskiy institut. Uskoriteli (Accelerators), no. 5, 1963, 75-90

TOPIC TAGS: linear accelerator, accelerator, electronaccelerator, linear electron accelerator

ABSTRACT: The paper develops approximate methods for estimating the parameters of linear electron accelerators with power feedback input; it compares the basic parameters of several feed systems within broad ranges of power generators, of energies, and of flows of accelerated particles; and, finally, it gives a basis for the choice of a feed system and of the structural parameters and gives an estimate of the variational characteristics of the Y-13 and Y-18 accelerators developed at the Inzhenerno-fizicheskiy institut (Engineering-Physics Institute). Orig. art. has: 8 figures, 5 tables and 34 formulas.

ASSOCIATION: Inzhenerno-fizicheskiy institut, Moscow (Engineering-Physics Institute)

Card 1/2

ACCESSION NR: AT4019728 S/2759/63/000/005/0134/0137

AUTHOR: Milovanov, O. S.; Shal'nov, A. V.

TITLE: Frequency drift in a magnetron directly connected with a linear accelerator channel

SOURCE: Moscow. Inzhenerno-fizicheskiy institut. Uskoriteli (Accelerators), no. 5, 1963, 134-137

TOPIC TAGS: frequency drift, magnetron, linear accelerator, magnetron oscillation, magnetron resonator, voltage, anode current, loading current

ABSTRACT: Magnetron oscillation frequency variation, arising as a result of the inconstancy of the external conditions, is called the frequency drift. The main reasons for such a frequency drift are: 1) temperature variations of the geometric dimensions of the accelerator waveguide system and of the magnetron resonator system, 2) magnetron frequency variation due to variation in magnetron anode current (or voltage), and 3) input impedance variation of the high frequency system of the accelerator due to variation in the loading current of the accelerated electrons. Under these conditions a stability criterion is obtained for the magnetron operation in the general case of band characteristics of the load. Orig. art. has: 15 formulas.

ACCESSION NR: AT4019728

ASSOCIATION: Inzhenerno-fizicheskiy institut, Moscow (Engineering-Physics Institute)

SUBMITTED: 00 DATE ACQ: 19Mar64 ENCL: 00

SUB CODE: NP, EE NO REF SOV: 003 OTHER: 000

Card 2/2

L 22487-65 EWT(m)/EPA(w)-2/EWA(m)-2 Pab-10/Pt-10 AEDC(a)/AFETR/IJP(c)

ACCESSION NR: AT5001491 S/2759/64/000/006/0017/0020

AUTHOR: Koroza, V. I.; Shalnov, A. V.

32
19
B+1

TITLE: Possibility of accelerating particles in a section with $\beta_V$ without prior bunching and without a longitudinal magnetic field

SOURCE: Moscow. Inzhenerno-fizicheskiy institut. Uskoriteli, no. 6, 1964, 17-20

TOPIC TAGS: particle acceleration, particle bunching, particle beam focusing

ABSTRACT: The authors consider the motion of particles in a radial direction in an accelerator at unity relative wave velocity without a longitudinal magnetic field. The spatial motion of the electrons was modeled with a "Polet" analog computer. The simulation method and the use of the computer were the same as described by Dem'yanenko at al. (Collection "Uskoriteli" [Accelerators], no. V, M., Gosatomizdat, 1963). The following conclusions are drawn: 1. Sections with unity relative wave velocity can be used to accelerate electrons without preliminary bunching and focusing by a longitudinal magnetic field. Thus, when $H = 0$, $A = 2$--$3$, $\xi'_H = 0.5$, and $\eta = 0.03$, the beam divergence is not too large

Card 1/2

APPROVED FOR RELEASE: 08/23/2000 CIA-RDP86-00513R001548420006-1"

L 22487-65
ACCESSION NR: AT5001491

and it is possible to dispense with focusing. 2. An increase in the injection energy in the absence of a focusing magnetic field leads to a decrease in the beam broadening. 3. An increase in the electric field intensity leads to broadening of the beam. /Abstractor's note: The notations are those used in the cited article by Dem'yanenko and are not defined here/. Orig. art. has: 3 figures.

ASSOCIATION: Inzhenerno-fizicheskiy institute, Moscow (Engineering-Physics Institute)

SUBMITTED: 00 ENCL: 00 SUB CODE: NP

NR REF SOV: 003 OTHER: 000

Card 2/2

AVER'YANOV, G.P.; GAVRILOV, N.M.; SHAL'NOV, A.V.

Design relationships for a double-helix wave guide. Uskoriteli no.6: 91-99 '64. (MIRA 18:2)

SHAMINOV, B.V.; TROYANSKAYA, I.Ya.

Certain results of a study of successive arrivals in reverse microseismic logging. Geofiz. razv. no. 15:40-44 '64. (MIRA 17:7)

ANISHCHENKO, G.N.; SHAL'NOV, B.V.

Field of the point source of a current on the surface of horizontally banded anisotropic cross sections with horizontal and vertical bedding of the anisotropic media. Prikl. geofiz. no.33:97-101 '62. (MIRA 15:10)
(Electric prospecting)

SHAL'NOV, I.I., inzhener.

Technology of producing shoes with decorative welts. Leg.prom. 14 no.9:16-17 S '54. (MLRA 7:9)
(Shoe industry)

SHAL'NOV, I.I., inzhener.

A wear-resistant shoe lining. Leg.prom.14 no.12:45-47 D '54.
(Shoe industry) (MLRA 8:2)

SHAL'NOV, I.I.

Over-all mechanization and automatization of operations in the factory no.2 "Proletarskaya pobeda." Kozh.-obuv.prom. 2 no.2:8-9 F '60. (MIRA 13:5)

1. Glavnyy inzhener obuvnoy fabriki No.2 "Proletarskaya pobeda."
(Leningrad--Shoe manufacture) (Automatic control)

SHAL'NOV, K. N.

USSR/Miscellaneous-Metallurgy

Card 1/1

Author : Shal'nov, K. N.

Title : Change in construction of the molding machine 265 M

Periodical : Lit. Proizv. 1, 8 - 9, Jan-Feb 1954

Abstract : In order to secure uninterrupted exploitation of the molding machine 265 M with welded broaching frame, the construction of the latter including the jarring table, was changed in such a way that the broaching frame is at rest during the jarring of the table. The removal of the model from the modified moulding machine 265 M is simplified because of the independent lifting of the broaching frame together with the packed mold, whereas the jarring table with the rigging remain in place.

Institution: ....

Submitted : ....

BOGDANOV, K. M., SHALNOV, M. I. and SHTUKKENBERG, Y. M.

"Some Results of Using a Tritium Tag in Radiobiological Research."

paper to be presented at 2nd UN Intl. Conf. on the peaceful uses of Atomic Energy, Geneva, 1 - 13 Sept 58.

AUTHOR: Shal'nov, M.I. SOV/89-4-6-8/30

TITLE: Tissue Doses of Fast and Superfast Neutrons (Tkanevyye dozy bystrykh i sverkhbystrykh neytronov)

PERIODICAL: Atomnaya energiya, 1958, Vol 4, Nr 6, pp 557-570 (USSR)

ABSTRACT: A tissue-like substance consisting of water and paraffin ($30 \times 30 \times 42$ $cm^3$, $30 \times 30 \times 2$ $cm^3$ and $30 \times 30 \times 5$ $cm^3$) was irradiated with a broad and a narrow beam of fast and superfast neutrons, and the tissue dose on the substance was measured. The neutrons were produced by the following 3 methods:

a) A thick beryllium target was bombarded with 13 MeV deuterons. Acceleration of the deuterons took place in a 1 1/2 m cyclotron. The neutrons were formed as a result of the reaction $Be^9$ (d, n) $B^{10}$.

b) A thick copper target was bombarded with deuterons which had been accelerated up to 280 MeV in a 6 m synchrocyclotron. Neutrons are produced by the stripping process.

c) A beryllium target was bombarded with protons accelerated up to 480 MeV in a 6 m synchrocyclotron. Neutrons are produced by the re-charging of protons.

Card 1/2

Tissue Doses of Fast and Superfast Neutrons SOV/ 89-4-6-8/30

The experimentally obtained curves for the maximum tissue dose are given for neutron energies of from 0.1 to 500 MeV. These curves (there are 14 of them) can be used for the calibration of dosimeters, and may also be used with good success for the purpose of determining the thickness of protective screen devices. Also the maximum permissible dose of neutron radiation for human beings is given. (It can be calculated on the basis of the curves). There are 9 figures, 3 tables, and 14 references, 7 of which are Soviet.

SUBMITTED: December 23, 1957

1. Neutrons--Dosage determinations 2. Neutrons--Physiological effects 3. Radiation meters--Calibration

Card 2/2

TSHAL'NOV, M.I.

21(4); 17(0) PHASE I BOOK EXPLOITATION SOV/2808

International Conference on the Peaceful Uses of Atomic Energy. 2d, Geneva, 1958

Doklady sovetskikh uchenykh; radiobiologiya i radiatsionnaya meditsina (Reports of Soviet Scientists; Radiobiology and Radiation Medicine) Moscow, Izd-vo Glav. upr. po ispol'zovaniyu atomnoy energii pri Sovete Ministrov SSSR, 1959. 429 p. 8,000 copies printed. (Series: Vtoraya Mezhdunarodnaya konferentsiya po mirnomu ispol'zovaniyu atomnoy energii. Trudy, tom 5)

General Ed.: A.V. Lebedinskiy, Corresponding Member, USSR Academy of Medical Sciences; Ed.: Z.S. Shirokova; Tech. Ed.: Ye.I. Mazel'.

PURPOSE: This book is intended for physicians, scientists, and engineers as well as for professors and students at vtuzes where radiobiology and radiation medicine are taught.

COVERAGE: This is Volume 5 of a 6-volume set of reports delivered by Soviet scientists at the Second International Conference on the Peaceful Uses of Atomic Energy, held on September 1-13, 1958, in Geneva. Volume 5 contains 32 reports edited by Candidates of Medical Sciences S.V. Levinskiy and V.V. Sedov. The reports cover problems of the biological effects of ionizing radiation, future consequences of radiation in small doses, genetic effects of radiation, treatment of radiation sickness, uses of radioactive isotopes in medical and biological research, uses of atomic energy for diagnostic and therapeutic purposes, soil absorption of uranium fission products, their intake by plants, and their storage in plants and foodstuffs. References accompany each report.

Reports of Soviet Scientists (Cont.) SOV/2808



Card 6/7

BOGDANOV, K.M.; SHAL'NOV, M.I.; SHTUKKENBERG, Yu.M.

Studying the dynamics of tritium oxide metabolism in the organism. Biofizika 4 no. 4:437-445 '59. (MIRA 14:4)
(TRITUM) (METABOLISM)

BOGDANOV, K.M.; SHAL'NOV, M.I.; SHTUKKENBERG, Yu.M.

Periodicity in the exchange of hydrogen between organic structures and water in the organism. Biofizika 4 no.5:582-587 '59.
(MIRA 14:6)

(TRITIUM) (METABOLISM)

APPROVED FOR RELEASE: 08/23/2000 CIA-RDP86-00513R001548420006-1"

21(3)

AUTHORS: Isayev, B. M., Shal'nov, M. I. SOV/89-6-1-7/33

TITLE: Measurement of the Skin Dose of Hard Bremsstrahlung (Izmereniye tkanevoy dozy zhestkogo tormoznogo izlucheniya)

PERIODICAL: Atomnaya energiya, 1959, Vol 6, Nr 1, pp 57 - 62 (USSR)

ABSTRACT: The $\gamma$-rays with a maximum energy of up to 250 MeV which occur as bremsstrahlung in a synchrotron were used for the purpose of distributing the penetration depth dose in a paraffin phantom. Investigation was carried out with maximum bremsstrahlung energies of 80, 180 and 250 MeV.
The paraffin phantom was composed of separate paraffin blocks having a cross section of 30.30 cm and a thickness of 1, 2, 3 and 5 cm. A maximum thickness of up to 41 cm could be attained, which the bremsstrahlung was able to penetrate completely. Between the paraffin layers an X-ray film of 24.30 cm cross section was placed. The first paraffin plate of the phantom was at a distance of 260 cm from the radiation output of the synchrotron.
The blackening intensity of the exposed films was measured along the entire breadth of the blackening spot by means of a densitometer, and was compared with the blackening intensity

Card 1/3

of a control film which had been irradiated with $Co^{60}$ $\gamma$-rays. The distribution of the depth dose is represented by a curve. The position of the ionization maxima can be well approximated by the analytical expression

$$\frac{d}{\sqrt{E}} = 1.14 \left(1-e^{-0.1E}\right)$$

It applies when $E > 4$ MeV and when the focal length is 100 cm. E is the maximum bremsstrahlung energy in MeV, d - the depth of the maximum in $g/cm^2$.
For the purpose of measuring the average skin dose of a hard bremsstrahlung it is possible to use either a thimble chamber or a calorimeter. The two measuring methods are compared with each other.
In conclusion, the admissible dose for various $\gamma$-energies is calculated and the corresponding curves are plotted. The results obtained agree well with the data given by reference 4. There are 6 figures and 4 references, 2 of which are Soviet.

SOV/89-6-1-7/33

Measurement of the Skin Dose of Hard Bremsstrahlung

SUBMITTED: December 23, 1957

Card 3/3

/

BLOKHINA, V.D.; SHAL'NOV, M.I.

Comparative studies on protein fractions of blood serum following single exposures to high energy protons and roentgen rays. Biul. eksp.biol.i med. 47 no.8:49-52 Ag '59. (MIRA 12:11)

1. Predstavlena deystvitel'nym chlenom AMN SSSR V.N. Orekhovichem.
(BLOOD PROTEINS radiation eff.)

23

PHASE I BOOK EXPLOITATION SOV/5628

Akademiya nauk SSSR. Institut biologicheskoy fiziki

Rol' perekisey i kisloroda v nachal'nykh stadiyakh radiobiologicheskogo effekta (Role of Peroxides and Oxygen During Primary Stages of Radiobiological Effects) Moscow, 1960. 157 p. 4,500 copies printed.

Responsible Ed.: A. M. Kuzin, Professor; Ed. of Publishing House: K. S. Trincher; Tech. Ed.: P. S. Kashina.

PURPOSE : This collection of articles is intended for scientists in radiobiology and biophysics.

COVERAGE: Reports in the collection deal with the role of peroxides and oxygen in the primary stages of a radiobiological effect. They were presented and discussed at a symposium held December 25-30, 1958, organized by the Institut biofiziki AN SSSR, (Institute of Biophysics, AS USSR). Twenty-eight Moscow scientists, radiobiologists, radiochemists, physicists, and

Card-1/5

physical chemists took an active part in the symposium. Between the time of its conclusion and the publication of the present book some of the materials were expanded. In addition to the authors the following scientists participated in the discussion: L. A. Tummerman, V. S. Tongur, G. M. Frank, Yu. A. Kriger, E. Ya. Grayevskiy, N. N. Demin, B. N. Tarusov, and I. V. Vereshchenskiy. References follow individual articles.

TABLE OF CONTENTS:

PHASE I BOOK EXPLOITATION SOV/4587

Shal'nov, Mikhail Ivanovich

Tkanevaya doza neytronov (Tissue Dose of Neutrons) Moscow, Atomizdat, 1960. 217 p. 6,000 copies printed.

Ed. (Title page): B.M. Isayev, Candidate of Physics and Mathematics; Ed. (Inside book): A.I. Zavodchikova; Tech. Ed.: N.A. Vlasova.

PURPOSE: This book is intended for personnel working with radioactive substances or requiring a knowledge of dosimetry techniques and methods.

COVERAGE: The book is an attempt to compile material already published on all the basic problems of tissue dosimetry, including the author's own experiments in this field. The work briefly reviews dosimetry methods for slow, fast and ultra-high speed neutrons, and indicates the possibilities of each method for measuring the tissue dose and the upper permissible dose of neutrons for man. The author thanks Professor L.M. Nemenov, Director of the Cyclotron Laboratory, Institut atomnoy energii AN SSSR (Institute of Atomic Energy AS USSR), and

Card ~~1/4~~